



Nov-22-2004

Serial Letter: KFM-LET-000064

California Department of Transportation
SFOBB – E2T1 Project
333 Burma Road
Oakland, CA 94607

Attention: Pedro Sanchez

Reference: SAS E2/T1 Foundation Project
Caltrans Contract No 04-0120E4
KFM Job No. 364/4347

Subject: OIW and USI Request for CCO; UT of PJP Welds

Dear Pedro:

Attached are letters from Oregon Iron Works and Universal Structural Inc., requesting a Contract Change Order (CCO) for ultrasonic testing of partial joint penetration welds. Also included for your information is a test report generated by NDE Professionals Inc., (NPI).

Please issue a contract change order to cover the cost and time impacts associated with the development and application of these UT procedures and the corresponding acceptance of the work.

Sincerely,
KIEWIT/FCI/MANSON, a JV

Christopher J. Villa
Deputy Project Director

cc: file



UNIVERSAL STRUCTURAL, INC.

604 S.E. Victory Ave.
Vancouver, WA 98661

P.O. Box 1030
Vancouver, WA 98666

Vancouver (360) 695-1261
Portland (503) 227-2419
FAX (360) 696-3590

November 11, 2004

Kiewit / FCI / Manson, JV (KFM)
220 Burma Road
Oakland, CA 94607
Phone: (510) 419-0120
Fax: (510) 839-0666

Attention: George Atkinson

Reference: SFOBB East Span Seismic Safety Project - T1 Tower Footing
USI #24142 (LTR 38.111104)

Subject: Request for CCO -UT of PJP Welds (NPI Report).

Gentlemen,

Universal Structural, Inc. (USI), Thompson Metal Fab, Inc. (TMF), and Oregon Iron Works, Inc. (OIW) have hired NPI to help develop a UT procedure for PJP welds that will be acceptable to Caltrans. As discussed in USI's previous letter 34.110404, the Special Provisions are incomplete regarding UT examination of PJP welds and AWS D1.5 does not provide any criteria for UT examination of PJP welds. Therefore, the Contract provides no information regarding the criteria used for development of a UT examination procedure, approval of such a procedure by the Engineer, application of a procedure, or acceptance of any results.

Section 10-1.21 Steel Structures; Inspection and Testing, note 8 of the Special Provisions states "UT examination of Partial Joint Penetration (PJP) welds shall confirm the specified weld size, and for weld sizes greater than 15mm, shall also evaluate the accessible weld volume to the requirements of AWS D1.5 for welds in compression."

As stated above, the Special Provisions as well as AWS D1.5 do not require, nor give provisions to develop a specific UT procedure for the UT examination of PJP welds to confirm the specified weld size or to evaluate the accessible weld volume.

Please reference the attached technical report from NPI, level III NPI titled "Ultrasonic Testing of PJP Weld Joint for Depth of Penetration" further validating USI, TMF and OIW position that ultrasonic examination of PJP welds by conventional (A scan) UT will not provide a repeatable, accurate, and efficient means of inspection.

At this time, USI, TMF, OIW, and NPI have exhausted our attempts to develop a UT procedure for the inspection of PJP welds as requested by Caltrans representatives. The UT procedure is beyond the applicable codes and industry standards and has not been provided in the contract documents. Therefore, USI and TMF requests this information be provided by Caltrans in an expedited manner in the form of a Contract Change Order (CCO) describing the UT examination procedures for PJP welds and related testing and acceptance criteria of the project. Additionally, if Caltrans wishes to pursue Phased Array this too will require a CCO.

Please be advised that USI and TMF have incurred considerable cost in trying to develop these procedures and are unable to determine the cost and schedule impacts that may result as we move ahead. Please consider this noticed that USI and TMF have and continue to be impacted by the above.



Category III

A Subsidiary of
HARDER MECHANICAL CONTRACTORS



UNIVERSAL STRUCTURAL, INC.

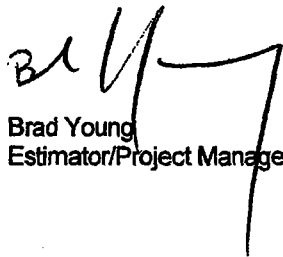
SFOBB T1 Foundation
USI # 24142

November 11, 2004

We are unable to determine the extent of the cost and schedule impacts at this time. We will forward this information after definitive direction is received and a complete analysis can be made.

Please advise Caltrans that their immediate attention to this matter is requested. If you have further comments or questions, please feel free to contact the undersigned at your earliest convenience.

Sincerely,
Universal Structural, Inc.

A handwritten signature in black ink, appearing to read 'Brad Young', is written over the printed name and title.

Brad Young
Estimator/Project Manager

cc: Dave Gardner
Dave Williams
Keith Stephenson
Chris Amonson
Ralph Seeley
file



Quality/NDE Professionals, Inc., 7505 NE Ambassador Place, Suite N
Portland, OR 97220
Office (503) 287.5255 Fax (503) 287.5992

Universal Structural Inc.

**Ultrasonic Testing of PJP Weld
Joints for Depth of Penetration**

An Evaluation

(Original Evaluation for Oregon Iron Works)

by

**NDE Professionals, Inc.
Portland, OR**



NDE Professionals, Inc., 7505 NE Ambassador Place, Suite N
Portland, OR 97220
Office (503) 287.5255 Fax (503) 287.5992

Ultrasonic Testing of Partial Joint Penetration Welds for Determining Depth of Penetration

Objective

On September 26th, 2004 - Nate Lindell/Oregon Iron Works - QC Manager employed the services of NDE Professionals, Inc. to assist in developing an ultrasonic test technique that would accurately determine the depth of weld penetration in a variety of partial joint penetration (PJP) weldments. The welded joints varied in thickness (50 to 65mm) and geometry (single bevel, double bevel and skewed single bevel). The depth of weld penetration ranged from 25 mm to 50 mm depending on the type of joint. General details of the weld joint geometry are illustrated in Figure 1.

Welded Mockups and Section Samples

OIW provided NPI with weld mock-ups simulating those to be encountered during production. Some mockups were sectioned and macro-etched; exposing the weld root. Each section was 12 to 13 mm in width and the depth of weld penetration on each side of the sample was measured. The lack of penetration land measurements on both sides varied as much as 2.5 mm which was attributed to the nature of the welding process. The actual weld throat dimension is determined by measuring the distance from the actual lack of penetration tip.

Calibration Reference Standard

Knowing the welded mockup samples could not be used as calibration standards, a calibration block was designed and machined with both 25mm and 50mm saw cuts simulating the lack of penetration depths.

Indication Orientation

By nature of the lack of penetration indication, early observations revealed three conditions that would affect test accuracy.

Root Condition

The orientation of the lack of penetration indication in all three joint designs suggested a 70° wedge angle from Face A and in the first leg would be optimal. Due to weld reinforcement, lesser angle wedges (45° and 60°) were not practical and not used. The lack of penetration tip, as observed from one of the sectioned weld samples, appeared to have a greater reflected area due to incomplete penetration (IP). Another showed lack of fusion (LOF) at the weld root (Ref. Illustration 1). These are obviously conditions that could affect interpretation and measurement values.



**NDE Professionals, Inc., 7505 NE Ambassador Place, Suite N
Portland, OR 97220
Office (503) 287.5255 Fax (503) 287.5992**

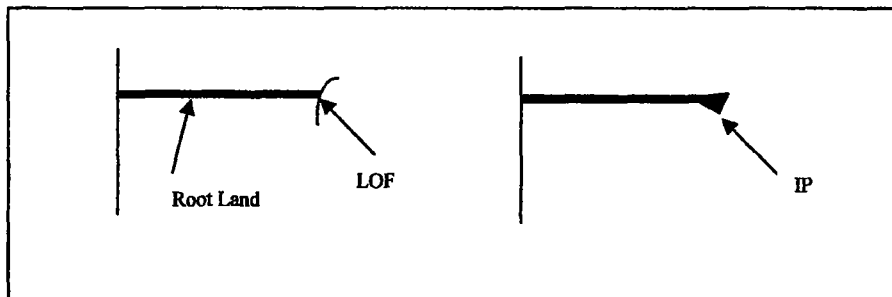


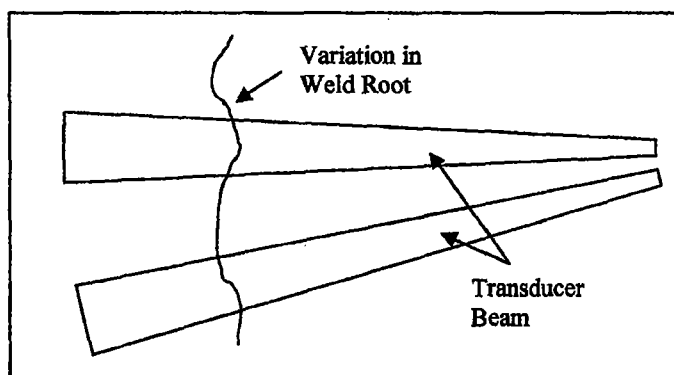
Illustration 1: Lack of Fusion and Penetration at the weld root.

Surface Roughness

The weld joint land is flame cut leaving a rough surface along the length of the land. The surface roughness creates small reflective surface areas. These small reflective areas are ultrasonic reflectors which could mask or confuse the actual tip signal.

Penetration Fluxuation

By nature of the welding process, the weld penetration will vary along the weld. Macro sections of the welded mockup indicated a depth of penetration vacillating between 0.5 mm and 2.5 mm in 12 mm of weld. The actual ultrasonic measurements in the sectioned samples could only be verified by an average of the varied measurements. This variation will require the UT operator to tediously manipulate the search unit to maximize signal response.





NDE Professionals, Inc., 7505 NE Ambassador Place, Suite N
Portland, OR 97220
Office (503) 287.5255 Fax (503) 287.5992

Ultrasonic Test Evaluation

NPI's approach was to use conventional A-scan ultrasonic techniques used in AWS D1.5 and characterization and sizing techniques described in AWS D1.1, Annex K. Although the lack of penetration indication was easily detected using both longitudinal straight beam, refracted L-wave and shear wave techniques, the actual goal was to determine the exact length of the root land or accurately locate the land tip (within ± 1.5 mm). Attempts were made to measure the indication height using the Annex K "rapid drop to baseline" technique. In most cases the root land had multiple reflective areas due to the surface roughness, thus creating multiple signals on the ultrasonic display. Because of the blending of the resulting multiple signals, the "rapid drop to baseline" technique failed to provide any meaningful results.

An ultrasonic sound wave simulation software program (Imagine 3-D by UTEX) was utilized to predict the behavior of the ultrasonic sound waves as they reflect and refract off the land tip surface. The simulation predicted reflections would occur at other locations along the land; the first peaked signal reflecting from the land tip (Ref. Figure 2).

An actual test calibration was performed from a modified IIW Block - 25 mm notch. As predicted, a rolling signal was observed that peaked at different locations along the display; the first peak at 25.10 mm and the second peak at 29.66 mm (Ref. Figure 4). This validated the predicted signal behavior.

Based on the predicted sound reflections and the results obtained from the calibration process, an actual test was performed on a weld mockup. Although there was some success in isolating a first and second peak, the signals were erratic and difficult to interpret. The screen captures shown in Figure 3 represent typical signal displays. In many cases, signal to noise ratio was less than two to one. Attempts were made to isolate the land tip signal using a variety of transducer frequencies, sizes and wedge angles but showed little improvement in signal resolution (Ref. Table 1 and 2).

| Transducer | | | Calibration Block – 25 mm Notch |
|-------------------|----------|-------|--|
| Size | Freq. | Wedge | |
| 0.5" | 2.25 Mhz | 70° | Signals @ 25 mm and 28 mm – equal amplitude |
| 0.5" | 5.0 Mhz | 70° | Signal peaks @ 27.5 mm and 28.5 mm – equal amplitude |
| AWS .75" X.75" | 2.25 Mhz | 70° | Signal peaks @ 24.0 mm – equal amplitude |
| 0.250" | 5.0 Mhz | 70° | Signal peaks @ 25.0 mm and 29 mm – equal amplitude |

Table 1: Calibration results from the IIW-Block -25 mm notch



NDE Professionals, Inc., 7505 NE Ambassador Place, Suite N
Portland, OR 97220
Office (503) 287.5255 Fax (503) 287.5992

| Physical Measurements | UT Measurements | |
|--|--|--|
| Skewed joint Side 1 measured depth = 50.0 mm Side 2 measured depth = 51.0 mm | 0.5"/2.25 Mhz/70° 0.5"/5.0 Mhz/70° 0.75" X 0.75"/2.25 Mhz/70° 0.250"/ 5.0 Mhz/70° | 47.0 mm 48.5 mm 44.5 mm 47.5 mm |
| Double Bevel 1 Side 1 measured depth = 26.0 mm Side 2 measured depth = 27.0 mm | 0.5"/2.25 Mhz/70° 0.5"/5.0 Mhz/70° 0.75" X 0.75"/2.25 Mhz/70° 0.250"/ 5.0 Mhz/70° | Unable to distinguish signal 25.5 mm 27.0 mm 27.0 mm |
| Double Bevel 2 Side 1 measured depth = 25.0 mm Side 2 measured depth = 27.0 mm | 0.5"/2.25 Mhz/70° 0.5"/5.0 Mhz/70° 0.75" X 0.75"/2.25 Mhz/70° 0.250"/ 5.0 Mhz/70° | Unable to distinguish signal 26.5 to 29.0 mm 29.25 mm 27.5 to 30.0 mm |

Table 2: UT results using various search units and obtaining measurements from the first amplitude signal

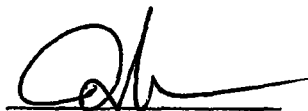
Note: Due to the interference of the weld toe, a 70° wedge was used for all ultrasonic evaluations.


Ultrasonic crack tip diffraction techniques were also considered but, by nature, a lack of penetration indication is not a crack and will not resonate diffracted sound waves in the same manner as a crack tip. Preliminary sizing information can be accomplished using an ID Creeping wave technique, but this technique does not provide a quantitative measurement and is only used for surface connected IP.


Summary

The ability to ultrasonically detect a weld land tip in the single, double or skewed bevel welded mockups is critical in determining the actual depth of weld penetration. Our goal was to determine if an A-scan ultrasonic technique could be relatively accurate, operator friendly and efficient. The estimated rate for production UT scanning would be 3 to 6 inches of weld per hour

Conventional A-scan ultrasonic testing proved to be very tedious, difficult to interpret and incapable of attaining a high degree of accuracy or repeatability.


Robert M. Hosman
NPI President
ASNT UT Level III #K-2002


John R. Clark
NPI Vice President
UT Level III


Lee Garrison
NPI Consultant
ASNT UT Level III #4427



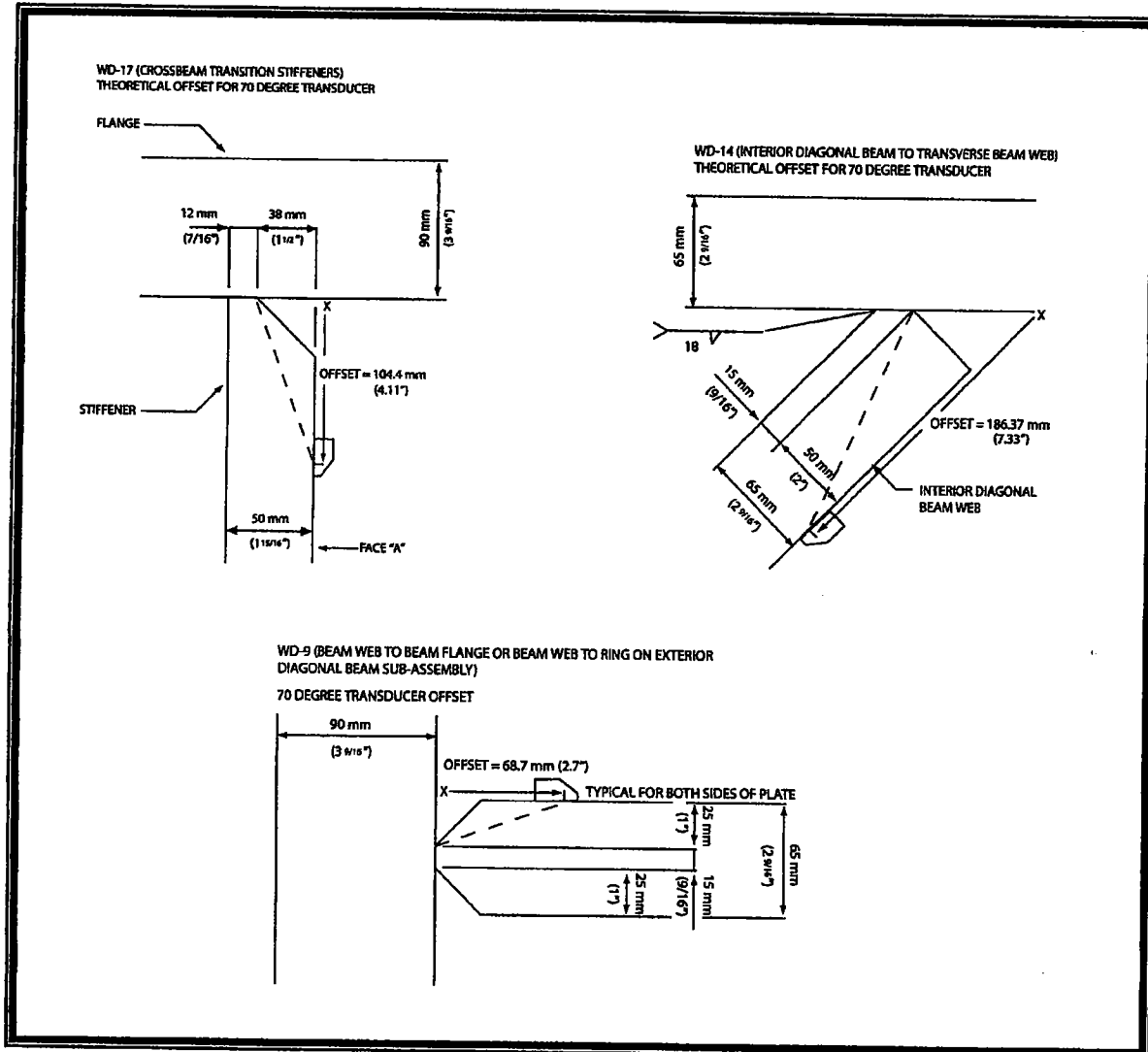
**NDE Professionals, Inc., 7505 NE Ambassador Place, Suite N
Portland, OR 97220
Office (503) 287.5255 Fax (503) 287.5992**

Figures

- Figure 1** General Detail of Partial Penetration Weld Joints
- Figure 2** Imagine 3-D Simulation of Wave Behavior
- Figure 3** A - Typical Screen Display of Calibration Block Signal Response
B – Typical Screen Display of Double Bevel First Signal Response
C - Typical Screen Display of Double Bevel Second Signal Response
- Figure 4** Screen Captures of Calibration Signal Responses
- Figure 5** Screen Captures of Mockup Signal Responses
- Figure 6** Photograph of Macro-etched Specimen of 45° Skewed Joint
- Figure 7** Photograph of Macro-etched Specimen of Double Bevel PJP



NDE Professionals, Inc., 7505 NE Ambassador Place, Suite N
Portland, OR 97220
Office (503) 287.5255 Fax (503) 287.5992



**Figure 1: Typical Weld Details – E-2 Pile Cap
Oakland –San Francisco Bay Bridge**



NDE Professionals, Inc. 7505 NE Ambassador Place, Suite N
Portland, Oregon 97220
Phone (503) 287-5255 Fax (503) 287-5992

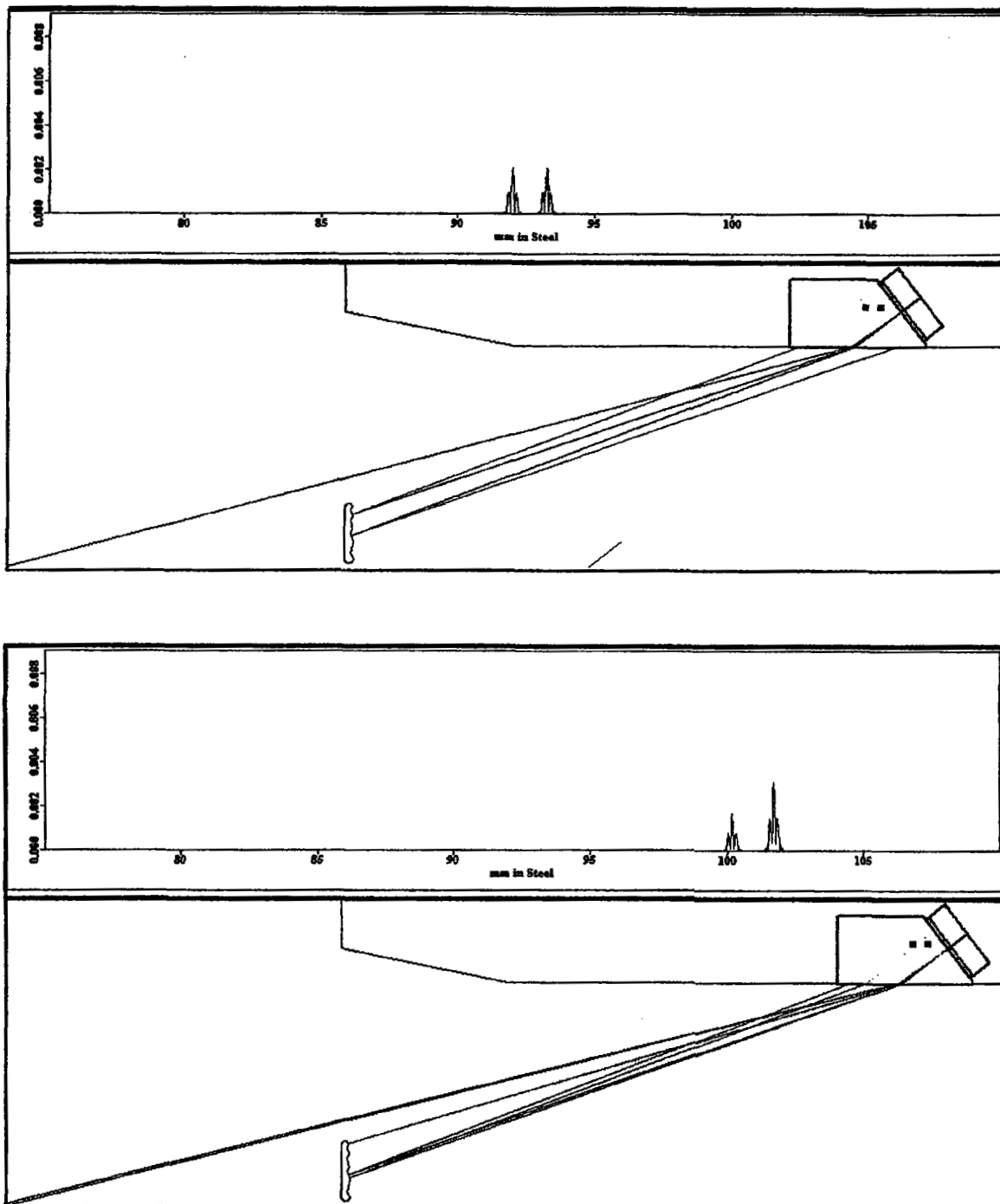


Figure 2

Imagine 3-D UTX simulation of reflected and refracted sound energy in PJP weld mock-ups.



NDE Professionals, Inc., 7505 NE Ambassador Place, Suite N
Portland, OR 97220
Office (503) 287.5255 Fax (503) 287.5992

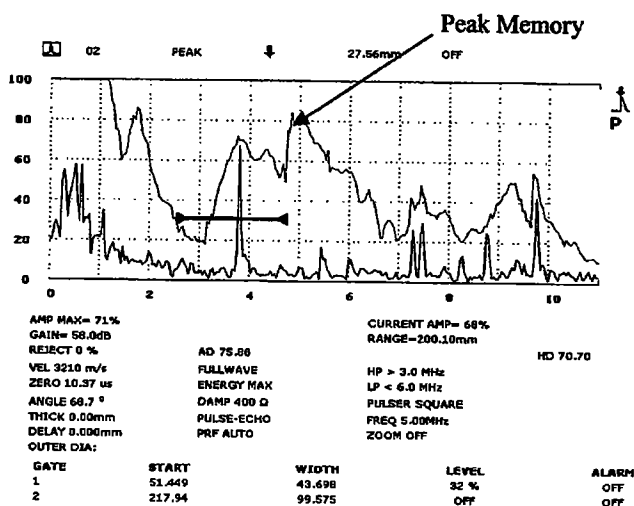


Figure 3-A: Typical A-Scan Screen Display and Signal Response of II-W Block-25 mm notch w/Peak Memory

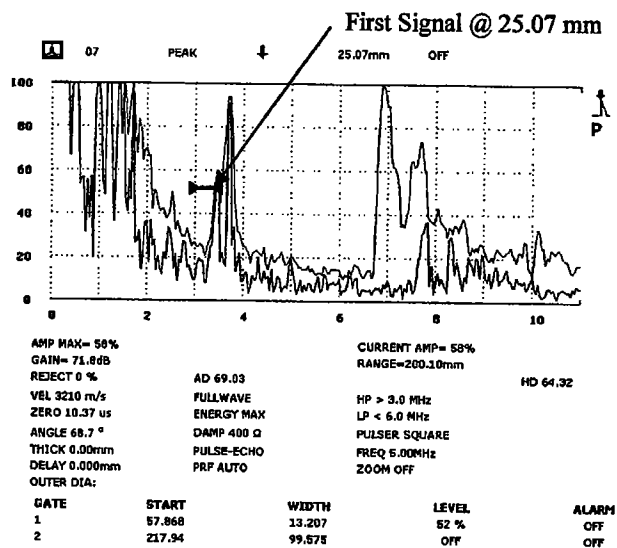


Figure 3-B: Typical A-Scan Display of Front Signal on Double Bevel PJP Tip



NDE Professionals, Inc., 7505 NE Ambassador Place, Suite N
Portland, OR 97220
Office (503) 287.5255 Fax (503) 287.5992

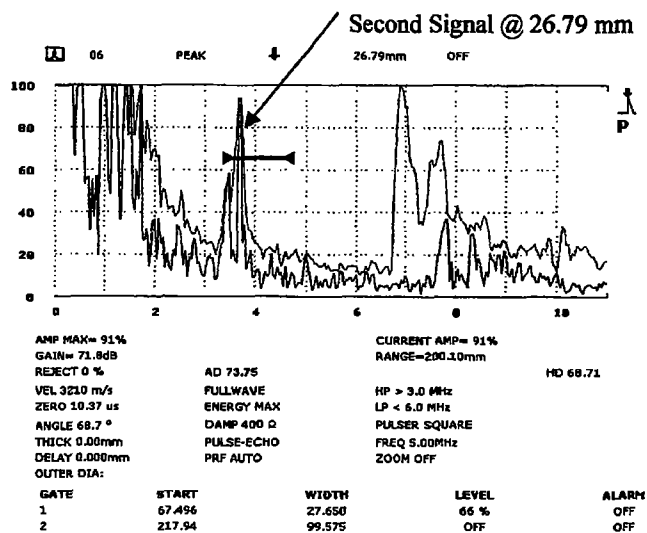


Figure 3-C: Typical A-Scan Display of Second Signal
on Double Bevel PJP Tip



NDE Professionals, Inc. 7505 NE Ambassador Place, Suite N
Portland, Oregon 97220
Phone (503) 287-5255 Fax (503) 287-5992

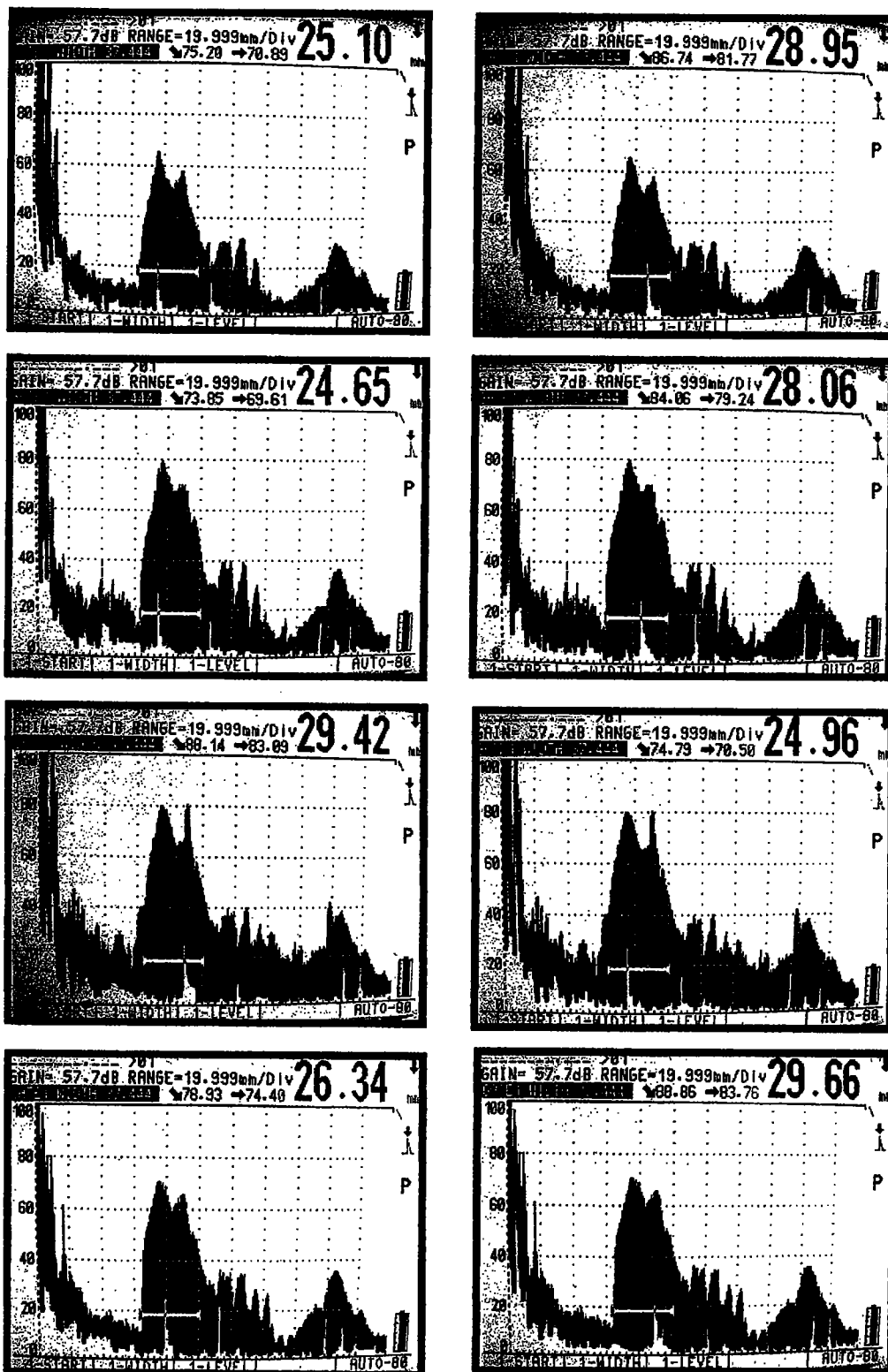


Figure 4

A-Scan screen images in peak memory mode of the 25 mm depth notch in the IIW block.
Transducer - .250"/ 5 MHz/ 70 degree wedge.



NDE Professionals, Inc. 7505 NE Ambassador Place, Suite N
Portland, Oregon 97220
Phone (503) 287-5255 Fax (503) 287-5992

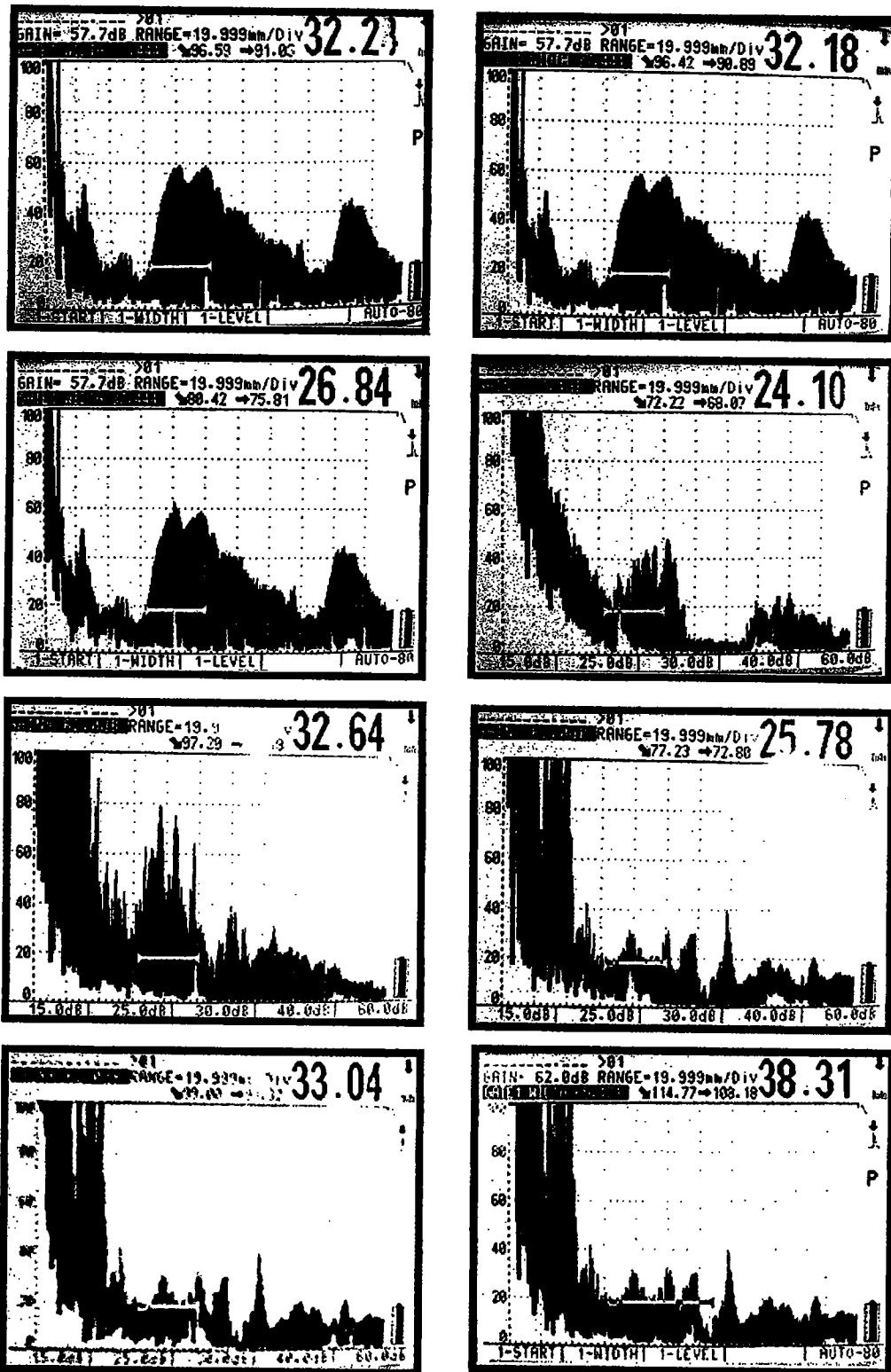


Figure 5

A-Scan images in peak memory mode of actual areas of LOP on a 66 mm thick welded mock-up. Required depth of penetration is 25 mm. Transducer - .250"/ 5 MHz/ 70 degree wedge



**NDE Professionals, Inc. 7505 NE Ambassador Place, Suite N
Portland, Oregon 97220
Phone (503) 287-5255 Fax (503) 287-5992**



Figure 6

Macro etch of 45 degree skewed PJP



NDE Professionals, Inc. 7505 NE Ambassador Place, Suite N
Portland, Oregon 97220
Phone (503) 287-5255 Fax (503) 287-5992



Figure 7

Macro etch of double bevel PJP



OREGON IRON WORKS, INC.

9700 S.E. LAWNFIELD ROAD • CLACKAMAS, OREGON 97015
TELEPHONE (503) 653-6300 • FAX (503) 653-5870

000204

| SAS FOUNDATIONS E2/T1 PROJECT | |
|-------------------------------|------------------------|
| KIEWIT / FCI / MANSON JV | |
| DATE: 11/9/04 | CONTRACT NO: 04-0120E4 |
| ROUTED BY: | NO: 04-0120E4 |
| TO: Chris Webb | SPECIAL NOTES: |
| INTERNAL KFM COPIES TO: | |
| | |
| EXTERNAL COPIES TO: | |
| | |
| SCANNED: Y N FILED TO: | |

November 5, 2004

KIEWIT / FCI / MANSON JV
220 Burma Rd.
PO Box 23223
Oakland, CA 94607

Reply to: SL-2083-26

Attention: Mr. Chris Webb

Reference: SAS E2/T1 FOUNDATIONS PROJECT / CONTRACT NO. 04-0120E4
OIW JOB #2083 / KFM ORDER NO. 4347

Subject: Ultrasonic Examination of Partial Joint Penetration (PJP) Welds

Gentlemen:

Section 10-1.21 Steel Structures; Inspection and Testing note 8 of the Special Provisions states "UT examination of Partial Joint Penetration (PJP) welds shall confirm the specified weld size, and for weld sizes greater than 15mm, shall also evaluate the accessible weld volume to the requirements of AWS D1.5 for welds in compression."

September 30, 2004 Oregon Iron Works, Inc. (OIW), Kiewit / FCI / Manson JV (KFM) and Caltrans discussed the examination of PJP welds. During this meeting OIW was informed by Caltrans, that OIW standard UT procedure would not be sufficient for the examination of PJP welds to confirm the specified weld size, and for weld sizes greater than 15mm, evaluate the accessible weld volume to the requirements of AWS D1.5 for welds in compression. However, a new procedure would have to be submitted for approval as well as the fabrication of mock-ups simulating those to be encountered during production. Prior to this meeting OIW was unaware of the requirement to develop such a procedure and mock-ups as they are not mentioned in the Special Provisions and / or AWS D1.5. OIW set a submittal date of October 11, 2004 for this procedure in order to maintain the project schedule. At that time, OIW contracted NDE Professionals Inc (NPI) for level III services and the research and develop of a new UT procedure.

H:\JOBS\2083\Serial Letters\SL-2083-26.doc

The information/data contained on this drawing/file/document (whether in electronic or hard format and copy) contains Proprietary and Confidential information of Oregon Iron Works, Inc. (OIW), 9700 SE Lawnfield Road, Clackamas, Oregon. The disclosure, release, distribution, or unauthorized use of this information/data without the express written consent of OIW is expressly prohibited.

Due to the timeline requested by OIW, NPI developed a procedure using fabricated mock-ups simulating those to be encountered during production. The procedure required a modified IIW type II calibration block to verify calibration accuracy. At time of development of the procedure, the calibration block was still being modified. The procedure was submitted to KFM October 11, 2004.

October 7, 2004 OIW held a meeting at the Clackamas facility. The agenda for the meeting was Ultrasonic Inspection (UT) of PJP welds. Present at this meeting were representatives from: OIW, Thompson Metal Fabrication (TMF), Universal Structural, Inc. (USI), KFM, Caltrans, and NPI. Again, it was stated by a Caltrans representative the examination of PJP welds to confirm the specified weld size, and for weld sizes greater than 15mm, evaluate the accessible weld volume to the requirements of AWS D1.5 for welds in compression would still require another procedure to be developed. However, the special provisions are unclear and incomplete giving no path to follow in regards to development of such a procedure, equipment to be used, angle selection as well as which face to scan from, as well as other specific information normally required for UT inspection. This information is required to develop a new procedure. NPI then evaluated the mock-ups following the new UT procedure giving Caltrans full advantage to give comments. At the request of Caltrans, OIW macro etched one end of a joint in order to verify the weld size was in fact the same as the UT machine was reading. This test proved inconclusive.

October 20, 2004 the modified calibration block was completed and given to NPI to use as a means to verify accuracy of calibration as stated in the submitted procedure. Following extensive research and development the method used to develop the UT procedure (A scan) revealed three conditions that affected the test accuracy: Root condition, surface roughness and penetration fluxuation.

October 22, 2004 OIW held a meeting at the office of NPI. The agenda for the meeting was to demonstrate the UT procedure to the Caltrans representatives. However, with the resent research and development revealing problems that would make the UT inspection inaccurate and inconclusive, NPI at the request of OIW, focused attention on new technology identified as "Phased Array". This new technology eliminated all of the conditions related to (A scan) UT. Following the demonstration of Phased Array the UT (A scan) procedure was presented resulting in the Caltrans representatives saying, "The Engineer will never go for that".

As stated above, the Special Provisions as well as AWS D1.5 do not require, nor give provisions to develop a specific UT procedure for the UT examination of PJP welds to confirm the specified weld size or to evaluate the accessible weld volume.

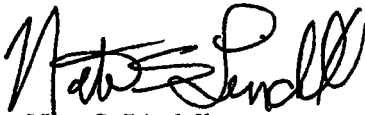
At this time, OIW has exhausted our attempts to develop a UT procedure for the inspection of PJP welds as requested by Caltrans representatives. OIW feels the information is beyond the applicable codes and industry standards and has not been provided in the contract documents. Therefore, OIW requests this information be provided by Caltrans in an expedited manner accompanied by a Contract Change Order (CCO) describing the procedure and method of payment for any and all research and development related to the original requested UT procedure including, mock ups and calibration standards. Additionally, if Caltrans wishes to pursue Phased Array this too will require a CCO.

Please reference the attached technical report from OIW, level III NPI titled "Ultrasonic Testing of PJP Weld Joint for Depth of Penetration" further validating OIW's position, which is ultrasonic examination of PJP welds by conventional (A scan) UT will not provide a repeatable, accurate, and efficient means of inspection.

If you have any further comments or questions, please feel free to contact the undersigned at your earliest convenience.

Sincerely,

OREGON IRON WORKS, INC.



Nate S. Lindell
Quality Control Manager

NSL:kl